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Rediscovery of *Trogia cyanea* and a record of *T. infundibuliformis* (*Marasmiaceae, Agaricales*) from Kerala State, India

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Abstract — *Trogia cyanea* is rediscovered from Kerala State, India, more than seven decades after its original discovery from Malaysia and *Trogia infundibuliformis* is recorded for the first time from Kerala. Both species are fully described and illustrated.

Key words — *Basidiomycota,* floristics, taxonomy

Introduction

The genus *Trogia* Fr. (*Marasmiaceae*, *Agaricales*, *Basidiomycota*) includes species with clitocyboid to omphalinoid basidiomata that are somewhat tough and readily restored when remoistened after drying. Corner (1966) employed a broad genus concept and accepted 56 species accommodating species from many closely related genera with a sarcodimitic tramal construction characterized by presence of long-celled, inflated generative hyphae bound together by intertwining slender, frequently septate, generative hyphae. Singer (1986) strongly opposed such a broad definition and accepted only three species. Singer considered the easily reviving basidiomata, the narrow and often furcated lamellae, the interwoven hyphae of lamellar trama and the characteristically pigmented trichodermial epicutis as the major distinctive features separating *Trogia* from close allies like *Clitocybe* (Fr.) Staude, *Gerronema* Singer, and *Neoclitocybe* Singer. While investigating the taxonomic value of sarcodimitic tissues in agarics, Redhead (1987) observed such tissues in several agaric genera. Instead of transferring them to a single genus, Redhead (1987) adopted the *Xerulaceae*, which he characterized by presence of sarcodimitic tissues. Corner (1991) defended his concept of *Trogia*. Unfortunately, the type species of *Trogia, T. montagnei* Fr. from India, has not been studied properly and its type specimen remains untraceable (Corner 1991, Wilson &

Desjardin 2005). Owing to this reason, the taxonomic boundaries of *Trogia* remain unknown. In their phylogenetic analyses, Wilson & Desjardin (2005) found *T. infundibuliformis,* a species phenetically similar to the protologue of *T. montagnei,* to form a sister group of marasmioid clade on a long branch. As far as we know, *T. infundibuliformis* is the only species of the genus treated in any molecular phylogenetic study and there is an urgent need for a comprehensive molecular phylogenetic study of the group.

Members of this predominantly tropical genus are strict saprobes encountered on dead wood and other plant debris on the forest floor. Manjula (1983) listed *T. montagnei* as the only acceptable record from India and Natarajan et al. (2005) listed *T. subviridis* Corner, *T. lilaceogrisea* Corner, and *T. infundibuliformis* as other Indian records of the genus. During our investigations on the agarics of Kerala, two species of *Trogia* were collected and examined. These collections are described and discussed below.

Materials and methods

Conventional morphology-based taxonomic methods were employed for this study. Microscopic observations were made on material stained with 1% aqueous solutions of phloxine and Congo red and mounted in 3% aqueous KOH. Melzer's reagent, cresyl blue, and cotton blue were used to observe whether the spores were dextrinoid, metachromatic, and cyanophilic respectively. Twenty basidiospores per specimen were measured. Colour codes refer to Kornerup & Wanscher (1978). All examined collections cited are deposited at Kew Herbarium and these collections are indicated by their Kew (Mycology) accession numbers (e.g., K(M)146176).

Taxonomic account

Trogia cyanea Corner, Monogr. Cantherelloid Fungi: 205. 1966. Figures 1A, 2A–E

Basidiomata omphalinoid, rather small, somewhat tough and leathery, distinctly revivescent, lignicolous. Pileus 17–30 mm diam., initially applanate with a distinctly depressed centre, later almost infundibuliform; surface dark blue (21F4, 21F3), hygrophanous and turning slightly paler, finely but distinctly striate from margin to half way towards the disc, finely pubescent under a lens, dry; margin inrolled when very young and finally becoming straight, initially entire, becoming somewhat eroded. Lamellae decurrent, moderately crowded, with lamellulae in three to four tiers, sometimes furcate, up to 1 mm thick, dark blue (21F4, 21F3); edge finely fimbriate, with fine grey dots. Context less than 1 mm thick, dark blue (21F4, 21F3). Stipe 18–30 × 1–2 mm, central, terete, solid, with a slightly discoid base surrounded by radiating mycelium;

surface concolorous with the pileus and lamellae, rather velutinous under a lens. Odour and taste not distinctive. Spore-print white.

Spores 6–9 × 4–6 µm, amygdaliform in face view, ellipsoid in profile, thin-walled, smooth, with refractive guttules, inamyloid, non-cyanophilic, non-metachromatic in cresyl blue. Basidia 21–34 × 7–10 µm, cylindrico-clavate, thin-walled, hyaline, with guttulate contents, 4-spored; sterigmata up to 5 µm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 20–63 × 6–9 µm, sinuoso-cylindric with an obtusely rounded apex, with a rather thick (up to 1 µm) greyish to dark greyish wall. Pleurocystidia absent. Lamellar trama irregular with somewhat loosely interwoven hyphae; hyphae 2–22 µm wide, hyaline, thin- to slightly thick-walled, often showing inflated, fusoid elements. Pileal trama interwoven; hyphae 2–21 µm wide, hyaline, thin- to slightly thick-walled, often with inflated fusoid elements. Pileipellis a cutis; hyphae 2–5 µm wide, not inflated, thin-walled, with greyish to dark greyish, plasmatic and encrusting pigments. Pileocystidia frequent, arising as erect lateral branches of cutis hyphae, 15–24 × 5–7 µm, short clavate with rounded apex, thin-walled, hyaline. Stipitipellis a cutis; hyphae 2–6.7 µm wide, thin-walled, with a pale grey plasmatic pigment. Caulocystidia numerous, scattered or in clusters, arising as lateral branches of cutis hyphae, 40–65 × 5–7 µm, versiform but mostly flexuous, thin- to thick-walled. Stipe trama composed of thick-walled (0.5–2 µm thick), mostly uninflated hyphae (2–7 µm wide) with some long and inflated (up to 20 µm) fusoid elements. Clamp connections frequent in lamellar, pileal and stipe trama.

Habitat: On decaying twigs and wood on forest floor, scattered or in small groups, locally abundant.

Collections examined — **INDIA, Kerala State, Calicut District,** Koyilandi: 27 Oct. 2004, T.K. Arun Kumar AK155 (K(M): 146176); 3 Nov. 2004, T. K. Arun Kumar AK165 (K(M): 146175); Peruvannamuzhi: 13 Nov. 2004, T.K. Arun Kumar AK198 (K(M): 146173); Koyilandi: 20 Nov. 2004, T.K. Arun Kumar AK155a (K(M): 146172); **Wayanad District,** Kottathara: 21 Nov. 2004, T.K. Arun Kumar AK204 (K(M): 146174; MALAYSIA, **MALAYA,** Pahang: 26 May 1931, E.J.H. Corner (K(M): 143823, HOLOTYPE).

Discussion: Easily reviving dark blue basidiomata, strongly hygrophanous pileal surface, discoid stipe base with radiating basal mycelium, and thick-walled, sinuoso-cylindric cheilocystidia are diagnostic of this species. Except for the size of the basidia, Corner's (1966, 1991) description of *T. cyanea* fits our collections perfectly. An examination of the type material of *T. cyanea* confirmed that our collections are conspecific with Corner's species. Remarkably, the Kerala collections seem to be the first report of the species after its original description, and outside the type locality. The type material of *T. cyanea* was collected by Corner from Malaysia in 1931.

Although Corner's broad concept of *Trogia* is highly disputed, accommodation of this species in that genus seems acceptable even under the restricted concept of the genus followed by Singer (1986) as it has almost all the distinguishing characters that Singer listed for *Trogia*. A combination of characters — darkly pigmented, easily reviving carpophores, narrow, coloured and often forked lamellae, and the socle-like stipe-base — excludes genera like *Clitocybe*, *Gerronema* and *Neoclitocybe*.

Other blue-green species of the genus, such as *Trogia pleurotoides* Corner and *T. stereoides* Corner, differ from *T. cyanea* in their habit and in some microscopic features. *Trogia pleurotoides* is laterally to eccentrically stipitate with an almost flabelliform fruit body and has minutely ornamented spores. A pleurotoid fruit body, a sarcotrimitic trama, and absence of lamellae and cystidia are the main characters that keep *T. stereoides* apart. *Trogia subviridis,* another blue-green species, differs from *T. cyanea* in having white to yellowish stipe and lamellae, pleurocystidia, and compactly arranged clavate or ventricose pileal elements. *Trogia calyculus* Corner is a very closely related species that can be separated from *T. cyanea* based on its relatively minute basidiomata, clavate to ventricose cheilocystidia, rarely with apical prolongations, and occasional pleurocystidia.

Trogia infundibuliformis Berk. & Broome, J. Linn. Soc., Bot. 14: 45. 1873

Figures 1 B; 2 F–J

Basidiomata small to somewhat medium-sized, omphalinoid, tough and leathery, distinctly revivescent, lignicolous. Pileus 15–52 mm diam., infundibuliform, often splitting radially from the margin to the centre into segments with age; surface dull white to brown (7E4) when young, becoming yellowish white (1A2), greyish orange (6B3), or light brown (6D5), mostly with a lilaceous tinge, darker at the striations on maturity, darkening on drying, initially slightly translucent-striate, distinctly sulcate-striate on maturity, almost glabrous to the naked eye but finely pubescent under a lens, dry; margin incurved when very young, becoming straight, initially entire, becoming irregular or at times lobate, finally fissile. Lamellae decurrent, distant to subclose, with lamellulae in one or two tiers, rarely furcate, up to 1 mm broad, concolorous with the pileus; edge grooved and finely fimbriate with fine grey dots when observed under a lens. Context less than 1 mm thick, yellowish white (1A2), greyish orange (6B3) or light brown (6D5). Stipe 12–23 × 1.5–4 mm, central to eccentric, fibrous, slightly compressed or terete, solid, arising from a discoid base with radiating basal mycelium; surface concolorous with the pileus and lamellae or darker, finely velutinous under a lens. Odour and taste not distinctive. Spore-print white.

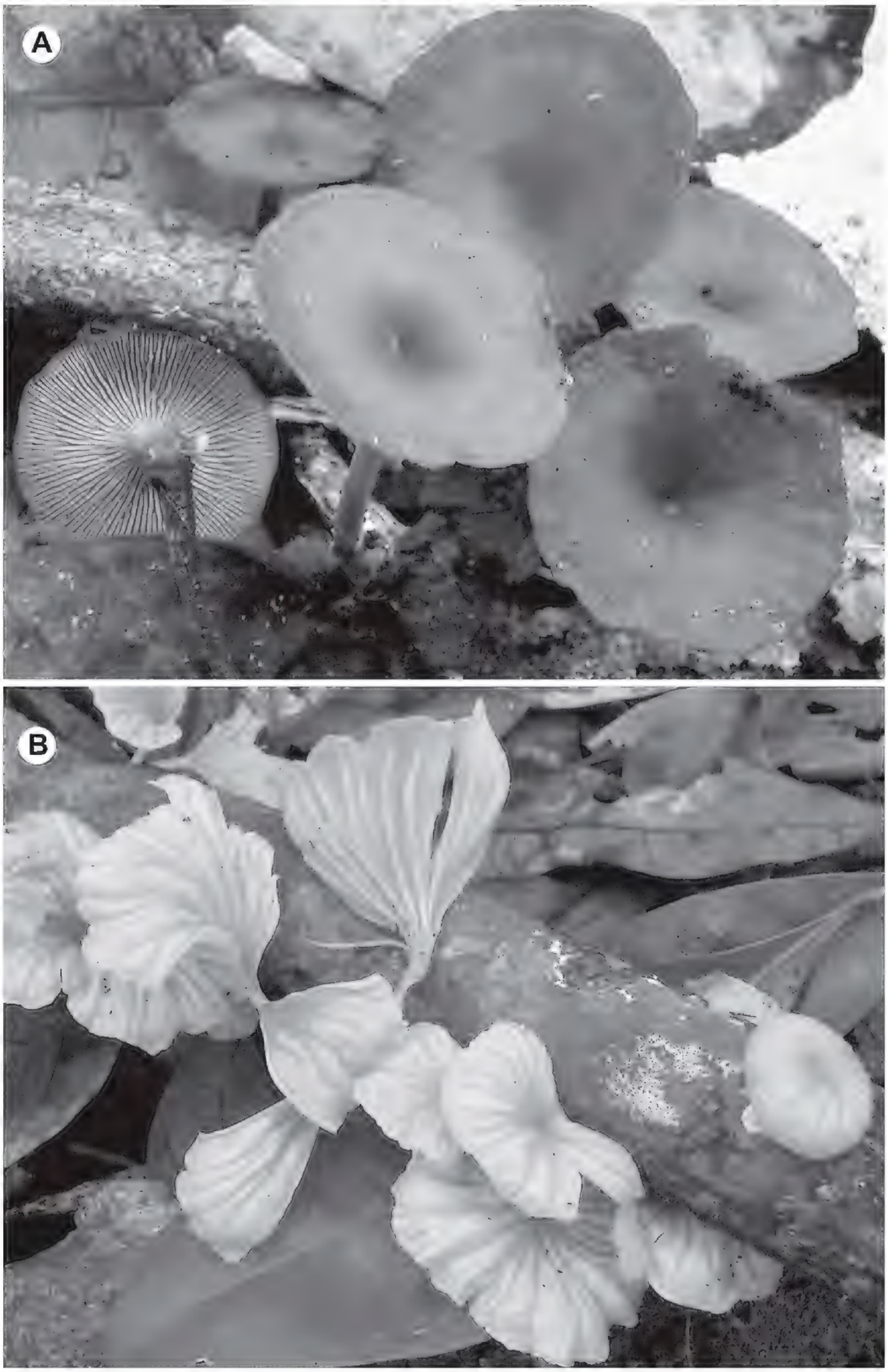

FIGURE 1. A, *Trogia cyanea*; B, *Trogia infundibuliformis*

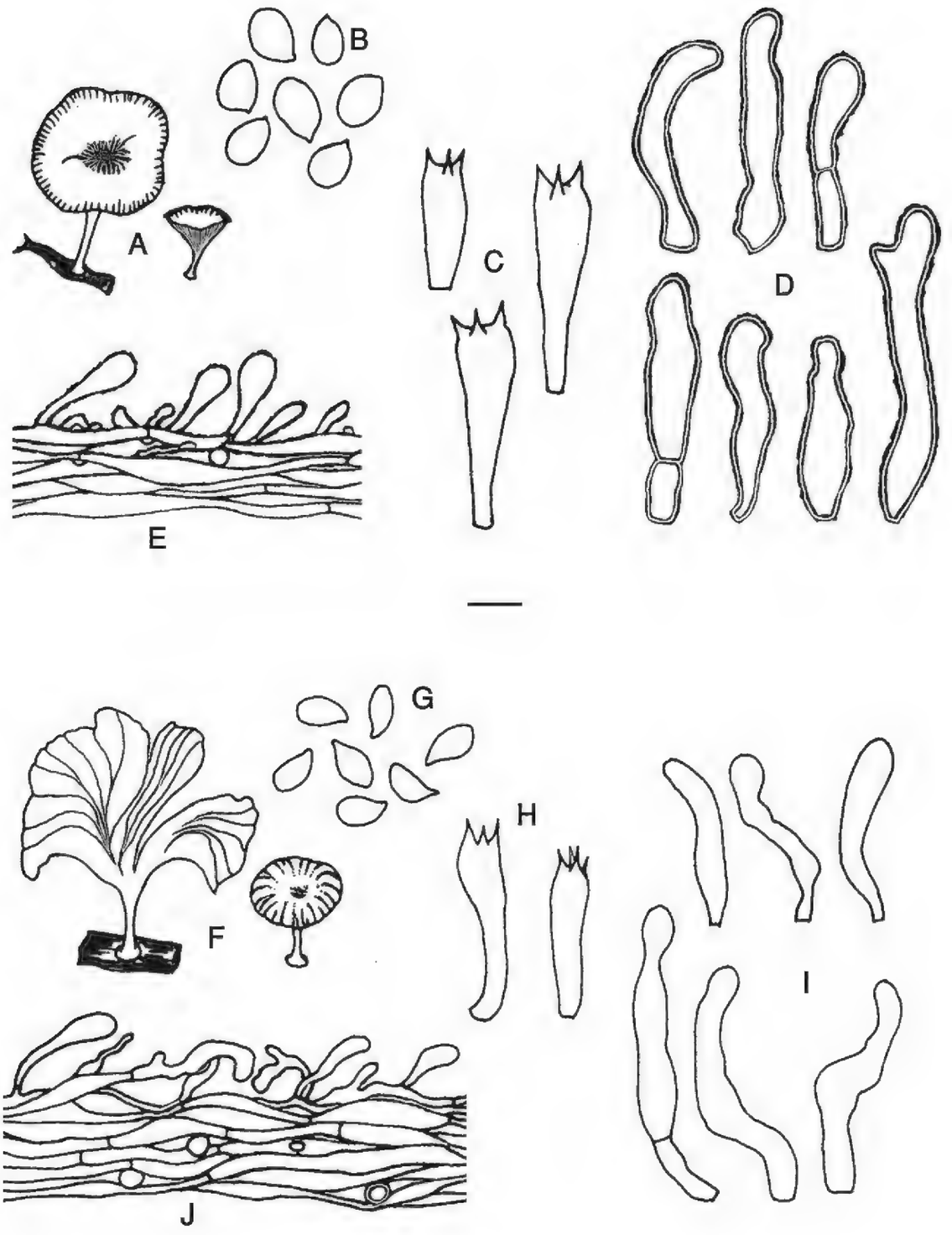

Figure 2. A–E *Trogia cyanea*:
A, basidiomata; B, basidiospores; C, basidia; D, cheilocystidia; E, pileipellis;
2. F–J *Trogia infundibuliformis*:
F, basidiomata; G, basidiospores; H, basidia; I, cheilocystidia; J, pileipellis.
Scale bar = 10 μm for microscopical structures and 10 mm for basidiomata.

Spores 7–10 × 4–5 µm, mostly oblong-ellipsoid, some ellipsoid and a few amygdaliform, thin-walled, smooth, with large refractive guttules, inamyloid, non-cyanophilic, non-metachromatic in cresyl blue. Basidia 29–50 × 4–7 µm, narrow, elongate clavate, thin-walled, hyaline, with guttulate contents, with prominent basal clamp-connections, 4-spored; sterigmata up to 5 µm long. Lamella-edge sterile with abundant cheilocystidia. Cheilocystidia 20–61 × 5–8 µm, cylindric, flexuous, strangulated or almost moniliform, with obtusely rounded apices, thin- to slightly or irregularly thick-walled (up to 1 µm), hyaline to pale grey. Pleurocystidia absent. Lamellar trama highly irregular; hyphae 2–15 µm wide, hyaline, thin- to thick-walled (up to 1 µm), often showing inflated, fusoid elements. Pileal trama interwoven; composed of 2–13 µm wide, hyaline, thick-walled (up to 1.5 µm), inamyloid hyphae often with inflated fusoid elements. Pileipellis a cutis of 2–6 µm wide, non-inflated, thin- to thick-walled, hyaline to pale grey plasmatic pigmented hyphae producing short, thin-walled, highly branched or nodulose outgrowths and occasionally disrupted with erect, 28–41 × 4–6.5 µm large cystidioid end-cells. Stipitipellis a cutis; hyphae 2–8 µm wide, slightly thick- to thick-walled (0.5–1 µm), hyaline or pale brown. Caulocystidia 31–52 × 5–7 µm, numerous, in clusters, similar to cheilocystidia in shape, thin- to thick-walled. Stipe trama made up of thick-walled (up to 2 µm), mostly uninflated hyphae (2–10 µm wide) with some long and inflated (up to 15 µm) fusoid elements. All hyphae with abundant clamp connections.

Habitat: On decaying twigs on forest floor, scattered or in groups.

Collections examined — **INDIA, Kerala State, Calicut District,** Thusharagiri: 22 July 2004, T.K. Arun Kumar AK73 (K(M): 146178); Peruvannamuzhi: 13 Nov. 2004, T.K. Arun Kumar AK192 (K(M): 146179); 5 July 2006, T.K. Arun Kumar AK411 (K(M) 146177).

Discussion: *Trogia infundibuliformis* is a frequently encountered wild agaric, readily recognized by its tough basidiomata that split radially in maturity. Basidiomata of almost the same age, even from close localities, show a wide colour range (from dull white to brown) and are slightly translucent striate. Fruit bodies arise from distinct discoidal bases. Except for their abundant cheilocystidia, the Kerala collections have characters markedly agreeing with the description of the species from Sri Lanka (Pegler 1986). Although both Corner (1966) and Pegler (1986) found the lamella-edge of *T. infundibuliformis* to be sterile, they did not find true cheilocystidia. The presence of fine grooves (canaliculations) at the edge of the deeply decurrent lamellae and the slightly larger spores distinguish this species from *T. buccinalis* (Mont.) Pat., another radially splitting species.

Tramal tissues of both the species treated here exhibited fusiform, inflated, thin- to slightly thick-walled generative hyphae together with frequently

branched, slender, septate hyphae, the hallmarks of Corner's sarcodimitic tissue.

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